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OF THE STATE OF CALIFORNIA

Application of Pacific Gas and Electric Company for Approval of the Retirement of Diablo Canyon Power Plant, Implementation of the Joint Proposal, And Recovery of Associated Costs Through Proposed Ratemaking Mechanisms	Application 16-08-006 (Filed August 11, 2016)

OPENING BRIEF AND REQUEST FOR ORAL ARGUMENT OF SAN LUIS OBISPO MOTHERS FOR PEACE TO APPLICATION 16-08-006

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INTRODUCTION

Pursuant to Rule 13.11 of the Commission's Rules of Practice and Procedure and the *Scoping Memo and Ruling of the Assigned Commissioner and Administrative Law Judge* dated November 18, 2016, San Luis Obispo Mothers for Peace ("SLOMFP") submits this opening brief for the above-entitled proceeding. SLOMFP requests that the Commission schedule oral argument in this proceeding pursuant to Rule 13.13(b) of the Commission's Rules of Practice and Procedure.

SLOMFP strongly supports the permanent retirement of Diablo Canyon Nuclear Power Plant ("Diablo Canyon," "the Plant" or "DCNPP"). While SLOMFP appreciates the Joint Proposal to shutter the Plant at the end of the current federal operating license in 2024/2025, SLOMFP questions the implied assumption contained in the Joint Proposal that the Plant should continue in operation through the end of the federal licensing period, and not retire sooner. To that end, SLOMFP recommends that the Commission order PG&E to conduct an assessment of environmental costs and benefits, and reduced safety and reliability risks, directly or indirectly resulting from a permanent shut down of Diablo Canyon unit 1 and unit 2 in 2019/2020 respectively. This analysis could be conducted in conjunction with the community impacts

assessment required by Senate Bill 968 (2016), now codified in Public Utilities Code § 712.5. In the alternative, or in addition to this assessment, the Commission should order PG&E to immediately prepare a contingency procurement plan for a potential early shutdown scenario of units 1 and 2 in 2019/2020.

ARGUMENT

I. 2.1. Timing of DCNPP's retirement

In this proceeding, the Commission invited parties to present testimony in support of PG&E's proposed plant retirement dates, or earlier or later retirement dates.[1] PG&E proposes shutting DCNPP in 2024/2025. The proposed timing appears to be not based upon need for the Plant, but merely because 2024/2025 is the end of the NRC operating license. The evidentiary record as a whole demonstrates that it is prudent to shut the Plant down in 2019/2020.

The Joint Proposal states that the utility intends to continue operation of the Plant from now until the end of its licensing period (in 2024/2025), because "[T]his transition period will help to ensure that power remains affordable and that we do not increase the use of fossil fuels while we move forward with California's energy vision. Equally important, this transition period will also provide essential time needed for [PG&E's] valued employees and the community to effectively plan for the future."[2] The record, as a whole, does not support the claim that an eight-year transition period is necessary to achieve the stated objectives, and given the reliability and environmental hazards posed by continued operation of the aging atomic Plant, keeping it open just for the sake of jobs (in light of the employee retention and replacement program) is not a wise balancing of risks.

The record demonstrates that on balance, it would be better for ratepayers and all Californians to shut DCNPP down sooner rather than later. SLOMFP recommends a shut-down date of 2019/2020, which would essentially line up with the first tranche of the Employee Program[3] as well as the anticipated reduction in demand for Diablo Canyon's electricity over the next few years.

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[1] *Scoping Memo and Ruling of the Assigned Commissioner and Administrative Law Judge* in Application 16-08-006, dated November 18, 2016, section 2.1, p. 23.

[2] See Revised Prepared Testimony of PG&E, Exhibit PGE-1, at p. 1-1

[3] The program has two phases of bonuses to encourage employees to stay at Diablo Canyon. The first bonus would be paid at the end of 2017 and would be conditioned upon the employee staying at the Plant

Reliability, safety, environmental, policy, and commercial risks and impacts associated with Diablo Canyon are simply too high to justify keeping the Plant online through the end of the federal operating license. Furthermore, continued operation places the seismically sensitive region at greater risk of an atomic power disaster and significant release of radioactivity adjacent to highly populated and environmentally sensitive areas.

The Commission has "vast, inherent power to take any action that is cognate and germane to utility regulation, supervision, and ratesetting" and is tasked with taking into account the public interest, safety and environment when making decisions on ratemaking applications, and the instant application should demand no less from this Commission.[4] The cost-effectiveness and public interest questions surrounding the continued operation of DCNPP suggest that the Joint Proposal[5] should be approved with modifications that would favor Plant shut down as soon as 2019/2020.

A) ***Aging Plant***

1. A Brief History

Diablo Canyon Unit 1 generated electricity for the first time in 1985, and Unit 2 began producing electricity one-year later, in 1986.[6] The Nuclear Regulatory Commission ("NRC") hypothesizes that the operating life of a nuclear reactor is approximately 40-years from the time it receives its operating license, but many fail well before reaching this NRC regulatory limit.[7] An NRC operating license is normally issued very near the time when the power plant's electricity is first generated.[8] Not so with Diablo Canyon, however.

Though Diablo Canyon began generating electricity 32 years ago, the decision to purchase the two atomic reactors and construct them at Diablo Canyon was made by PG&E 20-

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until August 31, 2020, or else face refunding the company the bonus paid. See *Prepared Testimony of PG&E witness King*, Exhibit PG&E-1, at pp.7-3 to 7-5.

[4] Pub. Util. Code §701.1; see *Southern California Edison Co. v. Public Utilities Com.* (2014) 227 Cal.App.4th 172, 187 [The Legislature declared that the principal goal of electric utilities' resource planning and investment "shall be to minimize the cost to society of the reliable energy services" that are provided by electricity, and "to improve the environment and to encourage the diversity of energy sources through," among other things, "development of renewable energy resources, such as wind, solar, biomass, and geothermal energy."]

[5] See Application 16-08-006, Attachment A.

[6] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 2

[7] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 2

[8] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 2

years earlier – during the mid-1960s.[9] This was during the halcyon period for nuclear power, when U.S., utility companies contracted for over 240 atomic power reactors, over half of which were eventually cancelled before being put into operation.[10] As SLOMFP's expert witness Dr. Arnold Gundersen points out:

"More than 100 atomic reactors were canceled after contracts were created, due to escalating construction costs and delayed and unmanageable construction schedules. While Diablo Canyon was not immune to either of those factors, its delays and cost overruns were so significant that PG&E became an example of what could go wrong during nuclear power plant design and construction." [11]

By the time Diablo Canyon came online, the original projected construction costs had increased ten-fold, from around $350 million to $5.8 *billion*.[12]

There are numerous issues and errors associated with the 20-year construction period of the Diablo Canyon reactors that create ongoing operational and regulatory risks today at Diablo Canyon.

One such error was made at the infancy of the plant: back in the 1960s, at the onset of the design process for Diablo Canyon, PG&E elected to use its own engineering staff, rather than engineers who specialized in atomic reactor projects.[13] Although PG&E eventually transferred responsibility to experienced contract engineers, that initial decision meant critical early engineering decisions were made by inexperienced staff, resulting in baseline defects that continue to impact the plant's current operation.[14]

Such carelessness was not unique to Diablo Canyon, but rather was endemic to the industry, as SLOMFP's Gundersen highlights by reference to the February 11, 1985 cover story in *Forbes Magazine* which detailed the overall mismanagement of the United States nuclear power program:

> The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale … only the blind, or the biased, can now think that the money has been well spent. It is a defeat for the U.S. consumer and for

[9] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 3
[10] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 3
[11] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 4:17-21 (where the page number is 4 and line numbers are 17-21)
[12] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at pp. 6; 26-27
[13] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 6
[14] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 7

the competitiveness of U.S. industry, for the utilities that undertook the program and for the private enterprise system that made it possible.[15]

2. Fast Forward to 2017

The situation has not improved over the years. An industry publication catering to electric utility executives succinctly summed up the current status of the nuclear power industry:

> Regardless of one's views of the social values of nuclear power — compelling cases can be made all around — as a business proposition nuclear stinks. The business case for existing nukes in the U.S. is also ominous… This comes on top of multiple closings of U.S. nukes unable to compete in competitive markets in recent years, state subsidies in Illinois and New York to keep uneconomic plants open, and threats of even more shutdowns… If it weren't for actions by state governments in Illinois and New York, the picture would look worse.[16]

The trend in nuclear power plant closures was foreseen almost four years ago by Dr. Mark Cooper, Senior Research Fellow with the Institute for Energy and the Environment at the Vermont Law School**.** In his comprehensive 2013 report entitled *Renaissance in Reverse: Competition Pushes Aging U.S. Nuclear Reactors to the Brink of Economic Abandonment*,[17] Dr. Cooper anticipated the near future closure of Diablo Canyon, along with another 37 reactors.

3. Aging Plant Equals Increased Risks

Diablo Canyon's procurement of mechanical components began more than 50 years ago. It is unlikely that Diablo Canyon reactors are mechanically capable of operating reliably until 2025 with their outmoded and degraded equipment.[18] Engineers explain the aging phenomenon by using what is known as the "Bathtub Curve."

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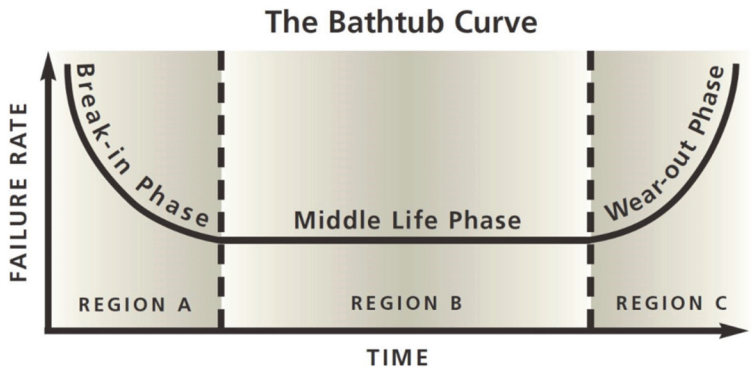
[15] *Prepared Direct Testimony of SLOMFP witness Gunderson* at p.7

[16] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 8, citing Kennedy Maize, *As a U.S. Business, Nuclear Power Stinks* (January 1, 2017) Power Engineering <http://www.powermag.com/blog/as-a-u-s-business-nuclear-power-stinks/>.

[17] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 9, http://216.30.191.148/atriskreactors.html.

[18] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 11:9-10.



The curve is a graph of failure rate according to age. The failure rate is relatively high in the beginning when "kinks" are being worked out; it flattens out during the middle life phase; and it rises again sharply in the end-of-life or at the "wear-out phase." Diablo Canyon generally is in the wear-out phase of the bathtub curve, when plant component failure can be expected to sharply increase.[19]

This means that the Plant will inevitably become costlier to operate. In its 2017 General Rate Case, PG&E identified major components that are degraded, including but not limited to:

- Hydraulic shock absorbers ("snubbers") – which are required to mitigate an earthquake,
- Worn valves in the safety injection system that pumps water into the reactor at very high pressures,
- Worn expansion joints in the condenser – as the condenser heats and expands, it grows and shrinks and these expansion joints accommodate that movement,
- Degraded piping that has become too thin from flow-accelerated corrosion; this physical failure requiring replacement was identified by the Flow Accelerated Corrosion program. Pipes that have thinned from flow-accelerated corrosion have worn so thin that they unexpectedly exploded and killed nearby workers at Surry Nuclear Power Plant in Virginia and other plants in Japan, and
- An outdated 1980s era designed analog safety instrumentation needs to be entirely replaced because spare parts are no longer available. It is meant to turn critical valves and

[19] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at pp. 17:16 through 18:3; Transcript, 604:25-28, PG&E Witness Strauss

pumps and measuring equipment for the safety system on and off, but because it still works on analog circuitry it cannot be adequately computerized.[20]

PG&E data provided in its last two General Rate Cases as well as the current proceeding supports a conclusion that there could be several major equipment failures, including the main generator stator, which is an extraordinarily large and expensive electrical generating component.[21]

Like other aging atomic power reactors evaluated by Dr. Mark Cooper in 2013, the costs of operating and maintaining Diablo Canyon are disproportionately high for the contribution the power plant makes to PG&E's electrical generation capacity and, therefore, further investment in the continued operation of Diablo Canyon is not a prudent economical capital expense for the utility.[22]

In an effort to control costs, PG&E is likely, and in fact plans, to conduct "work arounds" to avoid replacing some of the demonstrated failing or degraded aging components and systems.[23] The result is an increased risk of a breakage or failure that could lead to an extended outage or permanent early shut down.[24]

Despite PG&E's cost-control (work-around) measures[25], the financial costs of DCNPP continue to escalate on an annual basis.[26]

While PG&E claims that it has "procedures, corrective action programs, outage planning and scheduling processes, project management, and Quality Assurance Programs" which provide the "appropriate" levels of oversight to ensure "quality and safety" at Diablo Canyon[27] the fact remains that PG&E regularly runs afoul of quality and safety-related regulatory requirements.[28] Just in 2016 alone, the NRC identified over a dozen violations of regulatory requirements in unit

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[20] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at pp. 20:24 through 21:13
[21] Commission's Decision Authorizing Pacific Gas and Electric Company's General Rate Case Revenue Requirement for 2017-2019, Decision 17-05-013 in Application 15-09-001, et al., printed opinion at p.154.
[22] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 9.
[23] Transcript, p. 1065:5 through 1067:10, PG&E Witness Strickland.
[24] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 24:1-4
[25] Transcript, 1065:5 through 1066:9, PG&E Witness Strickland.
[26] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 24; *Prepared Direct Testimony of Robert Freehling,* Exhibit WEM-1, p. 3; *Prepared Direct Testimony of A4NR witness Geesman*, Exhibit A4NR-1, pp. 16-17.
[27] *Prepared Rebuttal Testimony of PG&E*, Exhibit PG&E-5, pp. 1-13 through 1-14; Transcript, 1067-1068, PG&E Witness Strickland.
[28] Transcript, p. 1068:20 through 19, PG&E Witness Strickland.

2.[29] In December, 2016, the NRC issued a White Finding for a relatively significant safety-related operations failure, resulting in a Notice of Violation and compelled corrective action.[30] While the NRC may permit PG&E to address their quality and safety failures through additional equipment upgrades, more robust maintenance programs or automation of existing systems, federal regulators aren't concerned with the cost implications thereof to ratepayers; but this Commission is.

4. Unit 1 Embrittlement

The atomic reactor for Unit 1 was designed over 50 years ago, and delivered to the Diablo Canyon site in 1973, approximately 20 years prior to the startup of the Plant. The reactor vessel was one of the first ever manufactured for the nuclear power industry, by a company with no previous experience manufacturing such a vessel. Because at that time the nuclear industry was in its infancy, it was not yet known that the material used to weld the Diablo Canyon Unit 1 reactor vessel is highly susceptible to radiation damage.

Ultimately, it was realized that reactor vessels damaged by radiation become embrittled and are susceptible to cracking and vessel failure. This phenomenon is known as *embrittlement* and is the subject of a lengthy analysis by Fairewinds Associates, Inc., attached to SLOMFP's expert witness Arnold Gundersen's prepared testimony as Appendix A.[31]

What the analysis demonstrates is that "irradiation embrittlement" is a significant issue for the type of reactor vessels such as Unit 1.[32] The NRC has labeled Diablo Canyon Unit 1 as one of the five most embrittled reactor vessels in the United States. Due to degradation and loss of integrity in this major component for the Unit 1 reactor, the reactor vessel poses a risk of what the NRC calls a Class 9 Accident, which is the worst nuclear catastrophe presently acknowledged by the NRC.[33]

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[29] Transcript, p. 1069:7-19, PG&E Witness Strickland; see https://www.nrc.gov/reactors/operating/oversight/2016q3/diab2_pim.pdf

[30] Transcript, p. 1068: 7-22, PG&E Witness Strickland; https://www.nrc.gov/reactors/operating/oversight/letters/diab_2016q3.pdf
See the NRC's website at https://public-blog.nrc-gateway.gov/2015/10/27/defining-the-color-of-oversight/ for color coding used by the agency to prioritize the findings with greater safety significance. The colors ascribed are green, white, yellow and red, with red being the most significant and moves an operating plant into the highest category for oversight followed by thousands of extra hours of inspection.

[31] Exhibit MFP-2.

[32] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, p. 5

[33] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, p. 3.

While the NRC has waived the reactor vessel inspection requirements until 2025 (the last inspection was conducted in 2005), despite acknowledging that Unit 1 is in the top 5 worst embrittled reactors in the country (out of a total of 99 remaining operational reactors),[34] the glaring fact remains that Unit 1 reactor vessel embrittlement poses a risk of a significant accident.[35] Reactor embrittlement can cause an atomic reactor to shatter like glass. Then the nuclear core leaves the atomic reactor and melts down into the containment, as it did at three of the atomic reactors at the Fukushima Daiichi site in Japan on March 11, 2011.[36]

A near-miss at California's Rancho Seco atomic reactor in 1978 provides an object lesson that pressurized water reactors, such as that at Diablo Canyon, are susceptible to abrupt changes in temperature and pressure that can be catastrophic for embrittled reactors.

In the case of Rancho Seco, while the welds on the reactor were severely stressed by the pressure and temperature changes that resulted from a cascade of electrical faults that started when a worker dropped a light bulb on the control room floor, the Pressurized Thermal Shock and vessel failure was avoided because the reactor was new and the welds had not yet experienced embrittlement by long-term neutron bombardment.[37]

Unfortunately, Diablo Canyon Unit 1 is particularly susceptible to a similar PTS (Pressurized Thermal Shock) like the one experienced at Rancho Seco, both because of its severely embrittled condition *and* because of its location in one of the most seismically active areas of the United States. An earthquake would cause a sudden emergency shutdown that could defeat the safety systems causing control room instruments to become unreliable due to "instrument chatter".[38] The resulting lack of accurate operator data due to instrument chatter was what ultimately caused the Rancho Seco mishap and the triple meltdown disaster at Fukushima Daiichi.[39]

More recent analyses now show that the atomic reactor vessel can crack even when it is not under pressure.[40]

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[34] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, p. 6; 20
[35] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, p. 5; 8-9
[36] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, pp. 3-4.
[37] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, pp. 10-11.
[38] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, p.11.
[39] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, pp. 10-11
[40] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A., pp.11

Unfortunately, the feasibility of repairing an embrittled nuclear reactor of the kind at Diablo Canyon Unit 1 has never been proven.[41]

Despite knowing that unit 1 reactor vessel's neutron embrittlement increases with each passing year, PG&E has elected not to inspect the embrittled welds before the end of unit 1's operating license in 2024.[42] This constitutes a deviation from industry standards, which require 10-year weld inspection intervals. PG&E has now elected to inspect on a 20-year interval basis instead, meaning that the next time it plans to inspect the welds will be after its current operating license expires. While PG&E is perfectly entitled to request a waiver from complying with industry standards, it certainly cannot then confirm with certainty that flaws are not developing in the reactor vessel welds. Absence of evidence is not evidence of absence.

Because PG&E has formally adopted an *argumentum ex silentio* approach, it cannot be concluded that embrittlement of unit 1 reactor vessel will not lead to a class 9 accident between now and 2025. Thus, when contemplating its ultimate decision on the Application before it, the Commission must take into account the financial and environmental risks associated with Diablo Canyon's unaddressed reactor embrittlement which increase with each passing day that the Plant is in operation.

B) Seismic Risks

Seismic risk issues are within the purview of the California Public Utilities Commission to ensure that ratepayers are neither financially harmed nor left without reliable services if PG&E continues to operate Diablo Canyon through the end of its current licensing period. The age and degradation of DCNPP, coupled with the likelihood of seismic activity in the area, creates economic and environmental risks to ratepayers that are not justified by the purported benefits of keeping the plant in operation post-2020. These risks include plant shutdowns and/or extensive required retrofits.[43]

Although the obvious risk arises from potential catastrophic core failure or failure of safety systems, PG&E's narrow focus on managing the risk of these extreme events harms its ratepayers. Even outwardly minimal damage following relatively minor seismic events has resulted in significant, wide-ranging problems for several power plants, not because of physical damage to the plants, but rather due to shutdowns to allow for safety investigations and

[41] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, pp. 16-19.
[42] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at App. A, pp. 19-20.
[43] *Prepared Direct Testimony of A4NR witness Geesman*, Exhibit A4NR-1, p.28.

reevaluation of existing standards.[44] And these regulatory-forced outages took place in a pre-Fukushima world; public concern and associated pressure on regulators has only increased since that event, making even longer outages likely following seismic events to come.[45]

John Geesman, a preeminent California energy policymaker, testified on behalf of the Alliance for Nuclear Responsibility that Diablo Canyon was subject to the risk of similar outages, with potential costs exceeding $1.8 billion in replacement power alone.[46]

The testimony of San Luis Obispo Mothers for Peace's expert witness David Jackson, Ph.D., professor emeritus in geology at University of California Los Angeles, echoes Mr. Geesman's concerns that Diablo Canyon is vulnerable to seismic effects other than core damage. Dr. Jackson notes that earthquake activity can cause damage to many systems required for safe and reliable operation of a nuclear power plant, and that even suspicion of such damage may interrupt normal plant operation.[47] Dr. Jackson expounds upon the concern of non-core damage by explaining that service interruptions could result from seismic activity far from the site of the plant, offering examples of external power, communication, and transportation facilities.[48] Dr. Gundersen also makes the case that PG&E has been delinquent in its reliance on a report indicating that "the plant and its major components are designed to withstand…a major seismic event," failing to analyze the resilience of minor components that are also critical to the plant's integrity during a seismic event.[49]

PG&E points to its AB1632-required Seismic Assessment of Diablo Canyon Power Plant Non-Safety Related Structures, Systems, and Components Report in an effort to rebut Dr. Jackson's and Dr. Gundersen's shared concerns that many of the Diablo Canyon's on and off-site components and systems have not been adequately assessed for seismic risk.[50] But PG&E cannot and does not confirm that all non-safety-related components and systems of plant and balance of plant have been assessed for seismic risk, which is the concern of SLOMFP's experts.

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[44] *Prepared Direct Testimony of A4NR witness Geesman*, Exhibit A4NR-1, pp.28 to 29.
[45] *Prepared Direct Testimony of A4NR witness Geesman*, Exhibit A4NR-1, p. 29
[46] *Prepared Direct Testimony of A4NR witness Geesman*, Exhibit A4NR-1, p.29. The figure of $1.8 billion is taken from a PG&E analysis, which estimated replacement power costs based on the assumption that replacement power costs would be $107 million per outage-month.
[47] *Prepared Direct Testimony of SLOMFP witness Jackson,* Exhibit MFP-1, at p. 3
[48] *Prepared Direct Testimony of SLOMFP witness Jackson,* Exhibit MFP-1, at p. 3
[49] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, Appendix B at pp. 36-40
[50] *Prepared Rebuttal Testimony of PG&E*, Exhibit PG&E-5, p. 1-15, line 28 through p. 1-16, line 18; p. 1-17 lines 3-22.

Instead, PG&E focuses on *major* components and those that are *directly* safety-related. When asked whether PG&E has assessed the seismic risk pertaining to all supporting components and auxiliary systems at Diablo Canyon, including off-site power plant equipment and systems, the answer was no.[51]

Dr. Jackson also presented evidence that the seismic reports used by PG&E in the relicensing case were flawed in their reliance on data subject to "uncertainties and assumptions."[52] Dr. Jackson testified that PG&E's analysis failed to account for (i) major earthquakes occurring off known faults; (ii) uncertainties as to fault location, particularly the Shoreline Fault; and (iii) the possibility of an earthquake's magnitude exceeding the limit suggested by the fault's known length.[53] Regardless of the myriad of venues in which these issues can be raised[54], the fact remains that they are issues, and issues that present credible risk and uncertainty.

In California, seismic activity is not an "if," but a "when." And although this was nominally considered in the construction of DCNPP, there is a demonstrated history of nuclear reactor design engineers underestimating the frequency and intensity of earthquakes.[55]

Dr. Jackson advises that "while we can't control natural earthquakes, our only defense is to reduce vulnerability."[56] Accelerating the retirement of DCNPP from 2024/2025 to 2019/2020 is a practical means of protecting against real and known vulnerabilities, both financial and physical.

C) DCNPP's Unabated Significant Adverse Impacts on Marine Resources

Nuclear reactors are the least efficient means of electric production because they discharge more heat to the environment than any other method of electricity production.[57] Atomic power reactors create a disproportionately large amount of waste heat for the electricity they produce compared to other electrical generation sources.[58]

Diablo Canyon uses ocean water to cool its reactors; the Plant withdraws water from the ocean using a single-pass system, also known as once-through cooling (OTC). This type of

[51] Transcript, p. 1072:2 through 1073:25, PG&E Witness Strickland.
[52] *Prepared Direct Testimony of SLOMFP witness Jackson,* Exhibit MFP-1, at p. 2
[53] *Prepared Direct Testimony of SLOMFP witness Jackson,* Exhibit MFP-1, at pp. 2 to 3
[54] *Prepared Rebuttal Testimony of PG&E*, Exhibit PG&E-5, at p. 1-16, lines 19-22.
[55] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 15
[56] *Prepared Direct Testimony of SLOMFP witness Jackson,* Exhibit MFP-1, at p. 1
[57] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 12.
[58] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 12

cooling system wreaks havoc upon the environment in two ways: first, by killing fish, eggs, and larvae and other wildlife through impingement and entrainment, and second, by discharging the tremendous amount of waste heat directly into adjacent waters of the state which has additional impact on raising the temperatures of the ocean environs thereby damaging aquatic species like spawning fish, oysters, crabs, plankton and plants upon which all aquatic species are dependent for survival.[59]

PG&E has resisted the implementation of mitigation measures such as cooling towers for decades, since even before the reactors began operation, despite public outcry and regulatory agency demands.[60]

The environmental damage caused by Diablo Canyon's once through cooling system is extraordinary. The Plant is sited less than a mile away from a Marine Protected Area[61], and draws in over 2.5 billion gallons of ocean water per day, killing an estimated 1.5 billion fish in early life stages each year.[62] That means PG&E is responsible for killing over ***48 billion*** sea creatures thus far by operating Diablo Canyon in the manner it has chosen to over the last 32 years.[63] In the words of the California Coastal Commission to the State Water Resources Control Board, Diablo Canyon is California's largest marine predator, although PG&E does not agree with that assessment.[64]

Despite possessing longtime, personal knowledge of the mammoth destruction of marine life that PG&E causes on a daily basis[65], even today, in 2017, PG&E flatly refuses to voluntarily cease once through cooling, so the environmental damage will certainly continue until Diablo

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[59] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 12
[60] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 13:1-17
[61] Transcript, p. 1084:7-11, PG&E Witness Strickland.
[62] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p 12
[63] As Dr. Gundersen points out: "When PG&E designed Diablo Canyon during the mid-1960s it allowed the waste heat from the nuclear reactors to be discharged directly into the Pacific Ocean, rather than installing cooling towers. By approximately 1980, scientists had acknowledged that such a tremendous amount of heated plant discharge water would damage the Pacific ecosystem. While it would have been only slightly more expensive to factor cooling tower construction into the original Diablo Canyon initial design and construction plan, when PG&E engineers initially designed the Diablo Canyon site, retrofitting the Diablo Canyon plants for cooling towers during the early 1980s would prove to be an extremely expensive proposal and an additional cost that ratepayers would be expected to bear." (*Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 13).
[64] Transcript 1084:12-21, PG&E Witness Strickland.
[65] Transcript 1083:26 through 1084:6, PG&E Witness Strickland.

Canyon permanently shutters or the federal operating license comes to an end, whichever is sooner.[66]

In considering the instant application and the exercise of its broad discretion, the Commission should take into account the substantial direct adverse harm to the marine environment that will result should Diablo Canyon continue business as usual until 2024/2025. The Commission should consider the destruction of an additional approximately ***12 billion*** fish specimens (or said another way, a nearly 20% increase in marine organism destruction) resulting from Diablo Canyon's continued operations for the next approximate eight years.

II. 2.2 Replacement Power Timing

SLOMFP hereby joins in Women's Energy Matters' (WEM) opening brief on this issue, and hereby incorporates by reference the points and authorities contained therein. SLOMFP agrees with WEM that the electricity from DCNPP can be replaced by other sources as early as 2019/2020. Given the rapid rise in the availability of solar, wind and geothermal energy and the rapid innovation in energy storage capacity, the eight-year timeline for closure of the plant is unnecessary and unwise, especially in light of the ever-growing Community Choice Aggregation movement. Early replacement of Diablo Canyon's energy services is entirely feasible.

SLOMFP submits that the transition from nuclear to renewable energy can and must be made much sooner than currently proposed by PG&E's Application to Implement the Revised Joint Proposal. The Commission should not wait for the Integrated Resources Plan process to run its course.

At the very least, the Commission should require PG&E to immediately develop a contingency plan for replacement power in the event that DCNPP experiences an extended outage or permanent shut down prior to 2024/2025. The test case should be 2019/2020 since this is the most relevant timeframe for reasons stated in WEM's opening brief and herein.

PG&E agrees that developing a contingency plan such as that proposed by WEM and SLOMFP would be prudent.[67] The only concern PG&E apparently has is that it would take time to develop.[68] As WEM points out, PG&E's testimony already contains elements of a contingency plan for early retirement, including projections of need for the electricity from

[66] Transcript, 1085:13-24, PG&E Witness Strickland.
[67] Transcript, 601:20-22, PG&E Witness Strauss
[68] Transcript, 602:15-17, PG&E Witness Strauss.

Diablo Canyon, potential resources for replacing the electricity generation, operations and capital costs of plant, and mitigation of community and work force impacts.

PG&E alternatively claims that even if there were an unplanned long-term outage, that reliability would not be impacted and therefore, the company reasons, a contingency plan is unnecessary.[69] This testimony is incongruent with PG&E's earlier claim that "This transition period [of 8 to 9 years] will help to ensure that power remains affordable and there is no increase in the use of fossil fuels…."[70]

A contingency plan in the event of early shut down should and must be developed, in light of the demonstrated history of nuclear plant failures causing prolonged outages or permanent shutdowns.[71] As Dr. Gundersen concluded, "the likelihood that Diablo Canyon would remain operational through 2025 is extremely low".[72] In its prepared rebuttal testimony, PG&E claims that SLOMFP's expert Dr. Gundersen's assertion that the potential for failure of mechanical components supports an early shut down is "not valid" because PG&E cares about safety and the plant has operated safely and reliably in the past.[73]

However, PG&E's disagreement with Dr. Gundersen's conclusion that the likelihood of Diablo Canyon remaining operational through 2025 is "extremely low" is limited to the issue of unit 1 reactor vessel embrittlement, whereas Dr. Gundersen draws his conclusion based upon a variety of aging plant facts and evidence, not just the unit 1 embrittlement problem.[74] Further, PG&E ignores the prudence and reliability issues that Dr. Gundersen raises with respect to embrittlement. PG&E rebuttal testimony on embrittlement is limited to the statement that PG&E disagrees with Dr. Gundersen that NRC license renewal was questionable due to the known

[69] Transcript, 603:3-7, PG&E Witness Strauss.
[70] See Revised Prepared Testimony of PG&E, Exhibit PGE-1, at p. 7-1
[71] E.g., SONGS in 2012; Arkansas 1 in 2013; Columbia Generating Station in 2011; Crystal River in 2009-2011; Duane Arnold in 2012; Indian Point in 2016; James A. Fitzpatrick in 2014; Fort Calhoun in 2011-2013; DC Cook in 2008 (*Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p, pp. 18-19); PG&E explicitly admits, as it must, that Diablo Canyon could experience mechanical failures that would result in unplanned extended outages. (Transcript 603:21-25, PG&E Witness Strauss.)
[72] *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, at p. 11:13-14.
[73] *Prepared Rebuttal Testimony of PG&E*, Exhibit PG&E-5, p. 1-13, lines 11-18.
[74] *Prepared Rebuttal Testimony of PG&E,* Exhibit PG&E-5, p. 1-12, lines 16-22 and p. 5-41, lines 3-13, compare *Prepared Direct Testimony of SLOMFP witness Gunderson,* Exhibit MFP-2, pp. 11:13 through 12:2 and Appendix A, pp. 17-24.

embrittlement issues. PG&E admits, as it must, that just because Diablo Canyon has operated safely for thirty years does not mean that it will continue to operate safely for the next eight.[75]

RECOMMENDATIONS

1) The Commission should approve PG&E's Application to Implement the Joint Proposal, but with modifications.

2) The Commission should order PG&E to conduct an assessment of environmental costs and benefits, and reduced safety and reliability risks, directly or indirectly resulting from a permanent shut down of Diablo Canyon unit 1 and unit 2 in 2019/2020 respectively. This analysis could be conducted in conjunction with the community impacts assessment required by Senate Bill 968[76], now codified in Public Utilities Code § 712.5, which states in relevant part, "the commission shall cause an assessment to be completed by no later than July 1, 2018, of the adverse and beneficial economic impacts, and the net economic effects, for the County of San Luis Obispo and the surrounding regions, that could occur if the Diablo Canyon Units 1 and 2 powerplant were to temporarily or permanently shut down before the powerplant's current operating licenses from the Nuclear Regulatory Commission expire[.]"

3) In addition, or in the alternative, to the above-recommended assessment, the Commission should order PG&E to immediately prepare a contingency procurement plan for a potential early shutdown scenario of units 1 and 2 in 2019/2020.

4) The Commission should order any other such relief as the Commission deems to be in the public interest.

Respectfully submitted, Dated: May 26, 2017

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[75] Transcript, 604:3-8, PG&E Witness Strauss.
[76] Stats.2016, Chapter 674.